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3.2.6 Superstructures

For typical highway bridge superstructures, the office generally selects among multiple options. If site and project conditions are appropriate the office prefers the following bridge types for which standard plans are available. The standard plans are available on the Office of Bridges and Structures web site:

http://www.iowadot.gov/bridge/index.htm

- **Three-span standard continuous concrete slab (CCS), J24, J30, J40, and J44 series [BDM 3.2.6.1.1]:** These standard CCS bridges are used for short spans up to 59 feet (17.983 m) or where minimum superstructure depth is required. There are nine bridge lengths from 70 feet (21.336 m) to 150 feet (45.720 m). The series includes roadway widths of 24 (which is not for primary highway system bridges), 30, 40, and 44 feet (7.315, 9.144, 12.192, and 13.411 m) and 0-, 15-, 30- and 45-degree skews. The standard plans are in English units only. The bridges are designed for HL-93 loading under the AASHTO LRFD Specifications.

- **Single span standard pretensioned prestressed concrete beam (PPCB), H24SI and H30SI series [BDM 3.2.6.1.2]:** These standard bridges have been withdrawn and will be redesigned using the AASHTO LRFD Specifications.

- **Three-span standard pretensioned prestressed concrete beam (PPCB), H24, H30, H40, and H44 series [BDM 3.2.6.1.4]:** These bridges are intended for highway or stream crossings. The standard beam bridges have nine lengths from 138'-10 to 243'-0 (42.316 to 74.066 m); 24- (which is not for primary highway system bridges), 30-, 40-, and 44-foot (7.315-, 9.144-, 12.192, and 13.411-m) roadways; and skews in 15-degree increments from 0 to 45 degrees, except that the H44 series is limited to a skew of 30 degrees. The standard plans are in English units only. The bridges are designed for HL-93 loading under the AASHTO LRFD Specifications. ~~The standard bridge plans for the two narrower roadways are under final review and will be released in 2010.~~

- **Three-span standard rolled steel beam (RSB) [BDM 3.2.6.1.5]:** These standard rolled steel beam bridges, which are intended primarily for stream crossings, have ten lengths from 160 to

340 feet (48.768 to 103.630 m), a roadway width of 40 feet (12.192 m), skews from 0 to 45 degrees, and span ratios of 0.75-1.00-0.75. The standard plans are in English units only. The bridges are designed for HL-93 loading under the AASHTO LRFD Specifications.~~ The standard bridge plans are under review and will be released in 2010.~~

If site conditions, roadway width, live loading, curvature, design method, or other considerations prevent use of the standard bridge designs the office prefers that the bridge be individually designed with either of the following.

- **Pretensioned prestressed concrete beam (PPCB) [BDM 3.2.6.1.6]:** PPCB bridges are used for spans to 155 feet (47.244 m). The designer shall select a single standard series of beams or bulb tee beams for the entire bridge. Within the series the designer should select among available beam lengths. For integral abutments the designer should limit skew to 45 degrees, and for stub abutments the designer should limit skew to 45 degrees.

- **Continuous welded plate girder (CWPG) [BDM 3.2.6.1.7]:** CWPG bridges are used for spans longer than 155 feet (47.244 m) or where minimum superstructure depth is required or where the horizontal alignment is sharply curved. There are no standard girder cross sections or lengths; each CWPG bridge is designed for the specific site and project conditions. For integral and stub abutments the designer should limit skew to 45 degrees.

~~The office also prefers that the bridge be configured for use of AutoBridge software. Use of AutoBridge has the following limitations:~~

- ~~Input and output in English units.~~
- ~~One to four spans.~~
- ~~Prestressed beam superstructure with the same standard beam type [BDM 3.2.6.1.6] in all spans.~~
- ~~Equal beam spacing.~~
- ~~Constant roadway width.~~
- ~~Horizontally straight bridge within one vertical curve or within tangent lines from one vertical curve.~~
- ~~Two integral abutments with identical plan dimensions, with optional changes in bearing and haunch thickness.~~
- ~~No longitudinal construction joints.~~
- ~~No splicing of transverse deck reinforcement.~~
- ~~Four identical wings.~~
- ~~Standard 7'-0 wings and wing extensions that may vary from the standard 6'-6 and 8'-0 lengths.~~

Grade separation design shall include the use of two-span bridges whenever practical as they minimize the use of piers, thereby increasing public safety. The designer shall consider various span arrangements based on the standard beam types available to optimize safety and cost efficiency. The face of pier and toe of berm slope shall be at or beyond the required clear zone distance for span arrangements with side piers. For the arrangements with no side piers, reference the article on berms [BDM 3.2.7.3] for additional guidance.

The guidelines listed above will cover most preliminary bridge designs. For exceptions and decisions regarding unusual project conditions the designer shall request approval from the supervising Section Leader.

3.2.6.1 Type and span

3.2.6.1.1 CCS J-series

For relatively small stream and valley crossings the office selects standard three-span continuous concrete slab superstructures. To facilitate the design of CCS bridges the office has prepared the signed standard J-series of plans.

The plans have the following parameters.

- The plans are in English units.
- The structures are designed for HL-93 loading.
- Roadway width is 24, 30, 40, or 44 feet (7.315, 9.144, 12.192, or 13.411 m). The 24-foot (7.315-m) width is intended for county bridges only.
- Skews may be 0, 15, 30, or 45 degrees.
- Bridge lengths range from 70 to 150 feet (21.336 to 45.720 m) as listed in Table 3.2.6.1.1.
- The maximum interior span of 59 feet (17.983 m) is approximately the upper limit for slab bridge economy.
- The ratios between interior and end spans are approximately 1.3 for efficiency.
- Substructure plans cover integral abutments and the option of monolithic or non-monolithic pier caps.
- There is the option for either an F-shape barrier or an open railing, except that only the open rail is available for the 24-foot roadway width.

Table 3.2.6.1.1. Lengths, spans, and depths for J24, J30, J40, and J44 three-span continuous concrete slab bridges (This table is the same as Table 5.6.2.1.1.)

Length (1) **feet (m)**	**End Span (2)** **feet (m)**	**Interior Span (3)** **feet (m)**	**Depth** **inches (mm)**
70 (21.336)	21.00 (6.401)	28.00 (8.534)	14.50 (368)
80 (24.384)	24.50 (7.468)	31.00 (9.449)	15.25 (387)
90 (27.432)	27.50 (8.382)	35.00 (10.668)	16.25 (413)
100 (30.480)	30.50 (9.296)	39.00 (11.887)	17.50 (445)
110 (33.528)	33.50 (10.211)	43.00 (13.106)	18.50 (470)
120 (36.576)	36.50 (11.125)	47.00 (14.326)	20.00 (508)
130 (39.624)	39.50 (12.040)	51.00 (15.545)	21.25 (540)
140 (42.672)	42.50 (12.954)	55.00 (16.764)	22.50 (572)
150 (45.720)	45.50 (13.868)	59.00 (17.983)	24.00 (610)

Table notes:

(1) Length is measured from centerline of abutment to centerline of abutment.
(2) End span is measured from center of abutment to center of pier.
(3) Interior span is measured from center of pier to center of pier.

3.2.6.1.2 Single-span PPCB HSI-series

This series of standard plans temporarily has been withdrawn for revision to the AASHTO LRFD Specifications.

3.2.6.1.3 Two-span BT-series

This series of standard plans has been withdrawn and will not be reissued.

3.2.6.1.4 Three-span PPCB H-series

For typical highway and stream crossings the office has developed standard plans for three-span pretensioned prestressed concrete beam (PPCB) bridges.

The signed standard plans have the following parameters.

- The plans are in English units.
- The structures are designed for HL-93 loading.
- Roadway width is 24, 30, 40, or 44 feet (7.315, 9.144, 12.192, or 13.411 m). The 24-foot (7.315-m) width is intended for county bridges only.
- Skews may be 0, 15, 30, or 45 degrees, except that the 45-degree skew is not available for the H44 series.

- The four- to seven-beam cross section makes use of standard A, B, and C beams, depending on span.
- Substructure plans cover integral abutments and pile bent or T-piers.
- There is the option for either an F-shape barrier or an open railing for all but the H24 series. The H24 series has an open railing only.

The ranges of lengths, spans, and beam depths are given in Table 3.2.6.1.4.

Table 3.2.6.1.4. Lengths, beams, and beam depths for H24, H30, H40, and H44 three-span PPCB bridges

Length (1) feet-inches (m)	**End Span (2) feet-inches (m)**	**Interior Span (3) feet-inches (m)**	**Beam Series**	**Beam Depth (4) feet-inches (mm)**
138-10 (42.316)	43-3 (13.183)	52-4 (15.951)	A	2-8 (8130
151-4 (46.126)	47-5 (14.453)	56-6 (17.221)	A	2-8 (813)
163-10 (49.936)	51-7 (15.723)	60-8 (18.491)	B	3-3 (991)
176-4 (53.746)	55-9 (16.993)	64-10 (19.761)	B	3-3 (991)
188-10 (57.556)	59-11 (18.263)	69-0 (21.031)	B	3-3 (991)
201-4 (61.366)	64-1 (19.533)	73-2 (22.301)	C	3-9 (1143)
213-10 (65.176)	68-3 (20.803)	77-4 (23.571)	C	3-9 (1143)
226-4 (68.986)	72-5 (22.073)	81-6 (24.841)	C	3-9 (1143)
243-0 (74.066)	80-9 (24.613)	81-6 (24.841)	C	3-9 (1143)

Table notes:

(1) Length is measured from centerline of abutment to centerline of abutment.
(2) End span is measured from centerline of abutment to centerline of pier.
(3) Interior span is measured from centerline of pier to centerline of pier.
(4) Add beam depth, 8-inch (203-mm) deck, and 3-inch (76-mm) estimated haunch to determine superstructure depth.

3.2.6.1.5 Three-span RSB-series

For typical stream crossings the office has developed signed standard plans for weathering steel, three-span rolled beam bridges. The 2010 plans meet the AASHTO LRFD Specifications. Because cost experience with these bridges is limited, if a standard rolled beam bridge is feasible for a bridge site the designer also shall layout an equivalent PPCB bridge and consult with the supervising Section Leader regarding the choice of bridge type.

The rolled beam plans have the following parameters.

- The plans are in English units.
- The structures are designed for HL-93 loading.
- Roadway width is 40 feet (12.192 m).
- Skews may be 0, 10, 20, 30, or 45 degrees.
- The six-beam cross section makes use of W30 to W44 (W750 to W1100) shapes.
- Substructure plans cover integral abutments and T-piers.
- Only an F-shape barrier rail is provided.

The range of lengths and spans are given in Table 3.2.6.1.5.

Table 3.2.6.1.5. Lengths, spans, and beam depths for RSB three-span continuous bridges

Length (1) Feet (m)	**End Span (2) feet (m)**	**Interior Span (3) Feet (m)**	**Beam Depth (4) feet-inches (mm)**
160 (48.768)	48 (14.630)	64 (19.507)	2-6 (762)
180 (54.864)	54 (16.459)	72 (21.946)	2-6 (762)
200 (60.960)	60 (18.288)	80 (24.384)	2-9 (838)
220 (67.056)	66 (20.117)	88 (26.822)	2-9 (838)
240 (73.152)	72 (21.946)	96 (29.261)	3-0 (914)
260 (79.248)	78 (23.774)	104 (31.699)	3-4 (1016)
280 (85.344)	84 (25.603)	112 (34.138)	3-4 (1016)
300 (91.440)	90 (27.432)	120 (36.576)	3-4 (1016)
320 (97.536)	96 (29.261)	128 (39.014)	3-4 (1016)
340 (103.632)	102 (31.090)	136 (41.453)	3-8 (1118)

Table notes:

(1) Length is measured from centerline of abutment to centerline of abutment.
(2) End span is measured from centerline of abutment to centerline of pier.
(3) Interior span is measured from centerline of pier to centerline of pier.
(4) Add beam depth, 8-inch (203-mm) deck, and 3-inch (76-mm) estimated haunch to determine superstructure depth.

These three-span standard bridges are not readily adaptable to other span, length, or skew conditions.

3.2.6.1.6 PPCB

The majority of the bridges designed for Iowa highways make use of standard pretensioned prestressed concrete beams (PPCB). Presently there are eight series of beams listed in Table 3.2.6.1.6 that are available. The eight series allow for design of bridges with single spans or multiple spans with varying span lengths.

In general the A-D series beams are preferred for both detailing and cost reasons. However, in some cases the bulb tee beams, BTB through BTE, may be better choices.

Various factors should be considered with the BTB through BTE series beams:

- Longer spans: For span lengths greater than 110 feet (33.500 m), consider the BTC, BTD, and BTE beams with a steel girder option.
- Vertical clearances: For structures with tight vertical clearances where the A-D series beams cannot be used, consider the shallower BTB and BTC beams with a steel girder option.
- Profile grade adjustments: For replacement bridge projects where substantial cost increases are incurred with profile grade adjustments necessary to accommodate the A-D series beams, consider the shallower BTB and BTC beams with a steel girder option. For roadway alignments on relocation, costs associated with profile grade adjustments are generally considered part of the plan development process.
- High skews: The bulb tee beams are designed for skews of 30 degrees or less. Use of the bulb tees in skewed structures will require wider abutment and pier caps to accommodate the wide bottom flange of 30 inches (760 mm). For bridges with skews greater than 30 degrees, the designer should consult with the supervising Section Leader.
- Estimated haunch limitations: When considering the use of bulb tee beams, take into account the geometrics of the roadway. For long spans on roadways with sharp vertical and/or horizontal curves, the longer bulb tee beams may not be feasible because of the large haunches necessary for vertical curves and offsets necessary for horizontal curves [BDM 3.2.6.3]. The preliminary designer may estimate the haunch dimensions using the calculation method given in the commentary. In cases where the estimated haunch limitations are exceeded, the designer should consider other beam types and span arrangements.

- Longer spans for reducing numbers of piers: For longer bridges, the use of the longer span bulb tee beams can reduce the number of piers and may provide a more economical structure.

For exceptions to the guidelines above and decisions regarding unusual project conditions the designer shall request approval from the supervising Section Leader.

Table 3.2.6.1.6. Standard pretensioned prestressed concrete beams {This table is formatted in landscape position on the next page.}

Table 3.2.6.1.6. Standard pretensioned prestressed concrete beams

Beam Type							
A (1)	B (1)	C (1)	D (1)	BTB (2)	BTC (2)	BTD (2)	BTE (2)
Beam Depth, feet-inches (mm)							
2-8 (813) (3)	3-3 (991) (3)	3-9 (1143) (3)	4-6 (1372) (3)	3-0 (914) (3)	3-9 (1143) (3)	4-6 (1372) (3)	5-3 (1600) (3)
Span Length, Centerline to Centerline of Bearing, feet-inches (m)							
30-0 (9.144)		30-0 (9.144)		30-0 (9.144)	30-0 (9.144)		
34-2 (10.414)	34-2 (10.414)	34-2 (10.414)	35-0 (10.668)	35-0 (10.668)	35-0 (10.668)		
38-4 (11.684)	38-4 (11.684)	38-4 (11.684)	40-0 (12.192)	40-0 (12.192)	40-0 (12.192)		
42-6 (12.954)	42-6 (12.954)	42-6 (12.954)					
46-8 (14.224)	46-8 (14.224)	46-8 (14.224)	45-0 (13.716)	45-0 (13.716)	45-0 (13.716)		
50-10 (15.494)	50-10 (15.494)	50-10 (15.494)	50-0 (15.240)	50-0 (15.240)	50-0 (15.240)	50-0 (15.240)	
55-0 (16.764)	55-0 (16.764)	55-0 (16.764)	55-0 (16.764)	55-0 (16.764)	55-0 (16.764)	55-0 (16.764)	
	59-2 (18.034)	59-2 (18.034)	60-0 (18.288)	60-0 (18.288)	60-0 (18.288)	60-0 (18.288)	60-0 (18.288)
	63-4 (19.304)	63-4 (19.304)	65-0 (19.812)	65-0 (19.812)	65-0 (19.812)	65-0 (19.812)	65-0 (19.812)
	67-6 (20.574)	67-6 (20.574)					
		71-8 (21.844)	70-0 (21.336)	70-0 (21.336)	70-0 (21.336)	70-0 (21.336)	70-0 (21.336)
		75-10 (23.114)	75-0 (22.860)	75-0 (22.860)	75-0 (22.860)	75-0 (22.860)	75-0 (22.860)
		80-0 (24.384)	80-0 (24.384)	80-0 (24.384)	80-0 (24.384)	80-0 (24.384)	80-0 (24.384)
			85-0 (25.908)	85-0 (25.908)	85-0 (25.908)	85-0 (25.908)	85-0 (25.908)
			90-0 (27.432)	90-0 (27.432)	90-0 (27.432)	90-0 (27.432)	90-0 (27.432)
			95-0 (28.956)	95-0 (28.956)	95-0 (28.956)	95-0 (28.956)	95-0 (28.956)
			100-0 (30.480)	100-0 (30.480)	100-0 (30.480)	100-0 (30.480)	100-0 (30.480)
			105-0 (32.004)	105-0 (32.004)	105-0 (32.004)	105-0 (32.004)	105-0 (32.004)
			110-0 (33.528)		110-0 (33.528)	110-0 (33.528)	110-0 (33.528)
					115-0 (35.052)	115-0 (35.052)	115-0 (35.052)
					120-0 (36.576)	120-0 (36.576)	120-0 (36.576)
						125-0 (38.100)	125-0 (38.100)
						130-0 (39.624)	130-0 (39.624)
						135-0 (41.148)	135-0 (41.148)
							140-0 (42.672)
							145-0 (44.196)
							150-0 (45.720)
							155-0 (47.244)

Table notes:

(1) The normal distance from centerline of beam bearing to centerline of pier is 9 inches (229 mm). Exceptions require approval of the supervising Section Leader.

(2) The normal distance from centerline of bulb tee bearing to centerline of pier is 12 inches (305 mm). Exceptions require approval of the supervising Section Leader.

(3) Add beam, 8-inch (203 mm) deck, and 2-inch (51 mm) estimated haunch depth to determine superstructure depth.

Standard cross sections for PPCB bridges have roadway widths of 30, 40, and 44 feet (9.144, 12.192, and 13.411 m) [OBS SS 4380, 4383-4385, 4556-BTC-4 to 4561-BTE-6, 4380-BTB-4 to 4385-BTE-6].

3.2.6.1.7 CWPG [AASHTO-LRFD 2.5.2.6.3]

Continuous welded plate girder (CWPG) bridges are used for spans longer than 155 feet (47.244 m) or where minimum superstructure depth is required or where the horizontal alignment is sharply curved. The approximate maximum economical span is 300 feet (91 m) for constant depth girders and about 550 feet (168 m) for haunched girders. The office has standard CWPG bridge cross sections but custom designs the girder cross sections for each project.

Because of continuity, span lengths generally are balanced to avoid uplift and other undesirable conditions. To avoid uplift at the abutment and significant imbalance the office prefers that an end span be a minimum of 54% of the length of the adjacent interior span. For balanced moments the end span should be in the range of 75 to 80% of the length of the adjacent interior span. As a maximum, the office prefers that the end span not exceed 80% of the adjacent interior span.

Unless the bridge site presents vertical clearance or profile grade issues, the goal is to set composite girder depths (slab + girder) at about 1/25 of the span. If it is necessary to use shallower girders, the office prefers that the designer consider the AASHTO LRFD span-to-depth ratios to be minimum [see BDM 5.5.2.4.1.12, BDM C3.2.6.1.7, and AASHTO-LRFD 2.5.2.6.3]. CWPG superstructures typically have four or five girders spaced at 8.25 feet (2.400 m) to 10.25 feet (3.000 m). Spacings to 12 feet (3.660 m) are considered on a case-by-case basis. Usually interior and exterior girders are designed to be the same.

For exceptions to the guidelines above and decisions regarding unusual project conditions the designer shall request approval from the supervising Section Leader.

3.2.6.2 Width

3.2.6.2.1 Highway

Guidelines for bridge widths for new and reconstructed highways and for county roads are given in two chapters of the Office of Design's Design Manual [OD DM 1C-1, 6B]. See also bridge width needs for bridge inspection and maintenance accessibility [BDM 3.2.6.7].

For new bridges carrying freeways, expressways, super-two highways, rural two-lane highways, transitional facilities, and ramps and loops, the recommended bridge width is the lane widths plus shoulder widths. For new bridges carrying reduced-speed urban facilities and for existing bridges carrying all types of highways the recommended bridge width may be different than the approach roadway width [OD DM 1C-1].

For bridges carrying county roads in interchanges, the width should be set as for non-National Highway System (NHS), rural two-lane highways [OD DM 6B-2, 1C-1].

For bridges carrying county roads not in interchanges, the minimum width should be 30 feet (9.000 m) for an average daily traffic (ADT) of 1500 or less and 40 feet for an ADT greater than 1500 [OD DM 6B-3]. The 30-foot (9.000-m) minimum width provides for wide farm machinery. For county roads, in all cases the designer shall discuss the proposed width with the county engineer.

For interstate projects with paved medians, the bridge width may be greater than the lane widths plus shoulder width. AASHTO's *A Policy on Design Standards--Interstate System, 5th Edition* [BDM 3.1.5.2] states that the width of all bridges, including grade separation structures, measured between rails, parapets, or barriers shall equal the full paved width of the approach roadways. Special considerations are listed below.

- **A single median roadway barrier rail**

  It is usually desirable to provide a 2-inch (50-mm) gap between bridges and a ~~4-inch~~ 6-inch (~~100~~150-mm) gap between back of bridge barrier rail. ~~The 2-inch (50-mm) normal slab overhang behind barrier is reduced to 1 inch (25 mm).~~ If the median portion of the bridges will be used for temporary traffic staging and the barrier rail will be installed in a later stage, it will be desirable to construct a slotted drain between the bridges to provide drainage in the area of staged traffic.

- **A separated median roadway barrier rail**

  The barrier rail on the bridges will normally align with the approach roadway barrier rail, with the deck slab extending the typical 2 inches (50 mm). To retain the approach fill and median roadway pavement, the abutments should maintain the 2-inch (50-mm) gap. To accommodate staged traffic in the median portion, the bridge decks should follow the temporary traffic staging guideline in the paragraph above.

- **Bridges where a light pole blister or sign truss are proposed in the median between the bridges.**

  A sufficient clear distance between bridges to accommodate a light pole blister or sign truss is 2'-10 (864 mm). Contact the Office of Traffic and Safety to coordinate signing and lighting needs. In some cases, the proposed light poles or signs can be relocated beyond the bridges, or shifted to the outside.

3.2.6.2.2 Sidewalk, separated path, and bicycle lane

Because sidewalks on highway structures are costly, the office generally includes sidewalks only on urban structures or where a local agency agrees to pay the cost [OD DM 11A-2]. The minimum clear width is 5 feet (1.500 m). Wider sidewalks may be considered on the basis of approach sidewalks. When a sidewalk is proposed on a bridge, the designer should review the appropriate office guidance to determine whether to design raised sidewalks or sidewalks at grade. To assist in coordination with the Office of Design, the determination should be noted on the TS&L.

To accommodate shared use paths on highway structures, the office normally follows the width guidelines in the Office of Design's Design Manual [OD DM 11A-1]. A separated path on a bridge should normally be 10 feet (3.000 m) wide. This path width does not require a design exception even though it is narrower than the width recommended by AASHTO's *Guide for the Development of Bicycle Facilities* [BDM 3.1.5.2]. If especially heavy use is anticipated, a 12- or 14-foot (3.6- or 4.2-meter) wide bike path should be considered.

In determining width for sidewalk or separated shared use path, consideration should be given to bridge inspection and maintenance (See [BDM 3.2.6.7]). If there is good access underneath the bridge, a high lift can be used from below. However, special consideration should be given to bridges with limited access underneath or very high structures. For these cases, some additional guidance is listed below:

- To provide access for a typical bridge layout, a snooper on the bridge can reach over a 5-foot (1.500-m) wide sidewalk.
- To provide access for a steel welded girder bridge, a system of catwalks or cables on the girders may be considered. The girders need to be more than 6 feet (1.800 m) deep so the inspectors can stand up straight.
- To provide access for a very limited subset of bridges, such as tied arches or deck trusses, the designer should first coordinate with the office's maintenance and inspection unit staff before setting sidewalk or path dimensions. In some cases, sidewalk or path widths greater than 5 feet (1.500 m) should be increased to 12 feet (3.600 m) to allow for snooper access.

For both paths and sidewalks, the width should be labeled as clear width on the TS&L. This is to ensure that rail attached to the separation barrier does not encroach on the needed design width.

Although less common on roadway structures, designated bike lanes without barrier separation from traffic may also need accommodation. To provide for a bicycle lane adjacent to a driving lane on a bridge, the bicycle lane width should be 5 feet (1.500 m) wide, as measured from barrier rail to bicycle lane stripe at edge of driving lane.

3.2.6.3 Horizontal curve

If a bridge is to be placed along a horizontally curved alignment, the designer will need to decide how to configure the superstructure. For relatively insignificant curves, a superstructure may be constructed with straight beams or girders between locations of support, but for significant curves the beams or girders will need to be curved. With straight beams or girders the office prefers that all supports be skewed at the same angle so that all members within a span are the same length. The decision to require horizontally curved members generally limits the superstructure type and increases both final design and construction cost, so the designer needs to make the decision carefully.

The office has the following policy for horizontal curves. First, the designer shall determine the distance between the chord and arc, defined here as M, at the midpoint of the bridge. If M does not exceed 4 inches (100 mm), the bridge shall be designed on a chord at the designated full shoulder width. If M is larger than 4 inches (100 mm) but not larger than 12 inches (300 mm), before proceeding the designer shall consult with the supervising Section Leader. In most cases, for this intermediate curvature the bridge should be designed on a chord but slightly wider to provide full shoulder width or greater at all locations. If M is greater than 12 inches (300 mm), the bridge shall be designed on a horizontal curve.

If the bridge deck is to be constructed on a horizontal curve, the designer needs to consider the use of beams on chords or curved steel girders. When considering straight beams, the designer should check the offset for each span between the arc and chord. If any offset exceeds 9 inches (225 mm) a curved steel beam bridge should be considered.

In all cases, whether the bridge is designed on a chord or on a curve, the designer shall label bridge stationing from the centerline of the approach roadway. The stationing should be referenced from the design alignment as shown in Figure 3.2.6.3.

{Drawing will be added in the future.}

Figure 3.2.6.3. Horizontally curved bridge stationing layout

3.2.6.3.1 Spiral curve

The use of spiral curves in roadways in Iowa is an accepted practice to improve alignment and safety. In order to minimize the effects of complicated roadway geometry in bridges, spiral curves will either be moved off the bridge or eliminated from use [OD DM 2C-~~1 ~~]1] in order to simplify design and construction.

3.2.6.4 Alignment and profile grade

It is preferable that the horizontal alignment for a bridge be straight. Final design software usually can expedite the final design for a straight bridge. Where a curve in the alignment affects only part of a bridge, the designer should consult with the Office of Design to adjust the horizontal alignment to move the curve off the bridge, if possible.

It is preferable that the vertical alignment not create a flat, difficult-to-drain location on the bridge. If a low point is located on the bridge, the designer should consult with the Office of Design to adjust the vertical alignment to move the low point off the bridge [OD DM 2B-1].

For a two-span overpass in an urban location, a convex vertical alignment may cause excessive haunch above pretensioned prestressed concrete beams (PPCBs). The designer should be aware of the potential difficulty and consult with the Office of Design, if necessary.

When developing plans for bridges on four lane divided highways:

- Show the “Profile Grade Line” on the Situation Plan.
- Stations on the “Situation Plan” view should be shown at the “Centerline of Approach Roadway”. The elevations shown in the “Longitudinal Section Along Centerline of Approach Roadway” should coincide with the stations shown in the “Situation Plan” view.

For all bridges shown in longitudinal section, ~~S~~show top of bridge deck elevation taking parabolic crown into account (see commentary for this article).

3.2.6.5 Cross slope drainage

If a bridge contains an area that is flat or difficult to drain, a revision to the profile grade or cross slope may be desired. In cross slope transition areas, the preliminary designer shall check the slope gradients on the bridge. Each gradient is the vector sum of the cross slope and the grade. If the slope gradient is less than 2%, a revision to the profile grade or cross slope is desired. If a grade or cross slope cannot be revised to obtain a 2% gradient, the preliminary designer shall work with the roadway designer and the section leader to find an acceptable solution.

3.2.6.6 Deck drainage

Bridge deck drain locations are determined in final design [BDM 5.8.4 ~~5.2.4.1.2~~].

3.2.6.7 Bridge inspection/maintenance accessibility

For bridges with limited access underneath or with very high structures, inspections are normally performed from the roadway above requiring the use of a snooper. The maximum reach under a bridge with a snooper arm is 45 feet (13.716 m) based on a zero degree skew. Inspection access may also be obtained from a pedestrian/recreational pathway. See the article on Sidewalk, separated path, and bicycle lane [BDM 3.2.6.2.2]. The designer should coordinate with OBS Bridge Maintenance and Inspection to determine maintenance needs.

Dual bridges, 45 feet (13.716 m) or wider, may require access from both the outside and median side. The desired median clear width to provide snooper access is 7 feet (2.134 m). If the maintenance needs for separation will result in a shift of the roadway alignment or barrier rail, the designer should coordinate with the Office of Design.

When access from above is not practical for steel girder bridges, the following options will need to be considered.

- Inspection walkways
- Safety cables attached to girder webs

Other considerations for steel girder bridges:

- Weathering steel may require periodic washing.
- Painting of the exterior fascias in the median is recommended.

3.2.6.8 Barrier rails [AASHTO-LRFD 13.7.2]

The Highway Division Management Team recently approved a new policy for determining Test Levels (TL) and the associated heights for railings on new bridges on interstate and primary road bridges. The policy is intended to be a supplement to the current AASHTO LRFD Specifications [AASHTO-LRFD 13.7.2].

The new policy states the following:

- The need for a TL-6, minimum height 92 inches (2.340 m) railing is not anticipated for the vast majority of bridges in Iowa.

- All interstate mainline bridges shall require a TL-5 railing, minimum height 44 inches, 42 inches plus 2 inches (1120 mm, 1070 mm plus 50 mm) for future overlay.
- Bridge railing test level and the associated height for other primary highways shall be evaluated by the Pre-Design Section in the Office of Design for replacement structures and the Preliminary Bridge Section in the Office of Bridges and Structures for other bridges. Basically the evaluation will follow the flow chart in the commentary [BDM C3.2.6.8] and additional information in the policy statement.

The preliminary designer should note on the preliminary situation plan when TL-5 or other special rail is proposed.

Normally the preliminary designer is not involved in bridge rehabilitation projects. However, if the preliminary designer is involved with retrofit barrier rails on deck replacement, superstructure replacement, or widening projects on interstate or primary highway systems the designer shall consult with the Chief Structural Engineer. There may be special circumstances that require exceptions to the flow chart in the commentary [BDM C3.2.6.8].